United States Virgin Islands
Handbook

On

Alternative Onsite Sewage

Disposal Systems –

Constructed Wetlands

Coastal Zone Management
Department of Planning and
Natural Resources
Government of the Virgin Islands

Executive Summary

This handbook was developed pursuant to the Virgin Islands Section 6217 Coastal Nonpoint Pollution Control Program. After review of the V.I. Section 6217 Coastal Nonpoint Pollution Control Program the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration recommended, in their findings, that the Virgin Islands "amend its program to include measures for alternative systems in areas unsuitable for conventional systems, appropriate performance standards for the alternative systems, and measures to assure that existing failing systems are repaired or replaced." This handbook, which includes performance standards for alternative onsite sewage disposal systems, is intended to assist the public in designing, installing, maintaining, and operating alternative on-site sewage disposal systems, particularly those systems employing constructed wetlands technology and its variants, in compliance with revisions to Title 12, Virgin Islands Code, Chapter 21 regarding on-site sewage disposal systems.

In addition, this document describes the conditions under which these revisions were necessitated, the applicable policies of the Government of the Virgin Islands and a descriptive comparison of the traditional and alternative systems for on-site sewage disposal.

This handbook was developed in conjunction with rules and regulations that include measures for alternative systems in areas unsuitable for conventional systems. Under a separate study, legislation is being drafted to assure that existing failing systems will be repaired or replaced.

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INTRODUCTION/BACKGROUND

Nonpoint source pollution, caused by runoff as it moves over and below the ground, has become the most serious cause of impairment of the surface, ground, and near-shore waters of the Virgin Islands. The two greatest problems associated with nonpoint source pollution in the Virgin Islands are sedimentation and bacterial contamination. Sedimentation occurs when eroded soil particles suspended in stormwater runoff are deposited onto floodplains or into guts and coastal waters. Sedimentation on reefs can smother them. Bacterial contamination is caused by failed septic and other sewage systems.

The contribution of failed septic tanks to nonpoint source pollution has prompted DPNR, through its Coastal Nonpoint Pollution Control Program, to develop this handbook and introduce new regulations regarding onsite sewage disposal. Residential sewage disposal, including the installation of septic tanks and disposal fields or seepage pits, is currently governed by Title 19 of the Virgin Island Code (Rules and Regulations, Chapter 53, Section 1404-70 to Section 1404-94). These regulations prescribe the size, dimensions, and locations or residential septic tanks, disposal fields, and seepage pits. They also specify under what conditions disposal fields and seepage pits are unsuitable, as in the case whenever the soil consists of "heavy, tight clay, hardpan, rock, or other impervious formations".

In many areas of the Virgin Islands the soil lacks the necessary two to four feet of pervious soil needed to construct a traditional onsite sewage disposal system (OSDS) comprising a septic tank and a disposal field or seepage pit. Yet these areas may also be so distant from existing public sewer lines as to make connection to the lines prohibitively expensive. As the population and level of development of the Virgin Islands has increased, it has become necessary to revise the regulations regarding onsite sewage disposal to include *alternative* onsite sewage disposal systems. These systems, constructed wetlands and variants thereof, have been successfully implemented in the USVI and elsewhere for the treatment of residential waste.

The impact of the revised regulations allow the use of effective alternatives to traditional septic tanks and public sewer systems while preserving the quality of Virgin Islands waters and reducing the effects of nonpoint source pollution.

Applicable Policies of the Government of the Virgin Islands

The commitment of the Government of the Virgin Islands to preserving the waters of the Virgin Islands is stated in the beginning of the Water Pollution control Act (Title 12, V.I. Code, Chapter 7, Section 181):

> "Whereas the pollution of the waters of the Virgin Islands constitute a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life, and impairs beneficial uses of water, it is hereby declared to be the public policy of the Virgin Islands to conserve the waters of the Virgin Islands and to protect, maintain, and improve the quality thereof for public and for domestic, recreational, and other beneficial uses; to provide that no waste be discharged into any waters of the Virgin Islands without first receiving the necessary treatment or other corrective action to protect the legitimate beneficial uses of such waters; to provide for the prevention, abatement and control of new or existing water pollution; [and] to authorize the Virgin Islands to implement the provisions of the Federal Water Pollution Control Act . . . .".

Additionally, the Coastal Zone Management Act (Title 12, V.I. Code, Chapter 21, Section 903) provides:

> "(a) The Legislature hereby finds and declares that:
> the coastal zone, and the lands and waters thereof, constitute a distinct and valuable natural resource of vital importance to the people and economy of the Virgin Islands;
> the protection of the natural and scenic resources of the coastal zone is of vital concern to present and future residents of the Virgin Islands
> . . . (4) the shorelines . . . enhance all aspects of the lives of the people of the Virgin Islands;
> . . . (5) to promote the public safety, health and welfare, and to protect public and private property, wildlife, ocean resources and the natural environment, it is necessary to preserve the ecological balance of the coastal zone, and to prevent its deterioration and destruction . . . ."
>
> "(b) The Legislature hereby determines that the basic goals of the Virgin Islands for its coastal resources are to:
> protect, maintain, preserve, and, where feasible, enhance and restore the overall quality of the environment in the coastal zone, the natural and man-made resources therein, and the scenic and historic resources of the coastal zone for the benefit of the residents and visitors of the Virgin Islands;
> . . . (9) maintain or increase coastal water quality through control of erosion, sedimentation, runoff, siltation, and sewage discharge . . . ."

Furthermore, Title 19, Chapter 53 (Sanitation), Sections 1404-72 and 1404-77 of the Virgin Islands Code state respectively:

> "No human excrement or material containing human excrement shall be deposited of in such a manner that it is likely to gain access to any waters except under conditions approved by the Department of Health."

And,

> "No drainage from a sewage disposal system shall be discharged into a street gutter or onto the surface of the ground. No effluent from any sewage disposal system shall discharge into any tributary of a public water supply."

Onsite Sewage Disposal Systems

The choice of the appropriate onsite sewage disposal system (OSDS) will depend, in part, upon the conditions at the site. If DPNR deems the site is unsuitable for a traditional system, then an alternative OSDS must be constructed.

Traditional Systems

The current method of choice for onsite disposal of residential sewage in the Virgin Islands consists of a septic tank and either a disposal field or a seepage pit. Household wastes enter the septic tank, where solids settle out to the bottom and scum, consisting primarily of grease and oils, floats to the top. Some breakdown of organic materials by bacteria and other microbes occurs in the septic tank. Liquids typically remain in the septic tank for one to two days, after which they flow either to a subsurface disposal field or a seepage pit. The disposal field consists of at least two rock-filled trenches through which effluent is carried in pervious pipes; the seepage pit is typically a rock-filled hole in the ground. The function of both is to provide soil absorption and filtration of the septic tank effluent. See Figure 1.

Virgin Islands regulations govern the size, dimensions, and location of each component of the system. The required capacity of a residential septic tank depends on the number of bedrooms in the residence, with a minimum capacity of 500 gallons in the case of a residence with not more than two bedrooms. (See Title 19, V.I. Rules and Regulations, Chapter 53, Section 1404-84). Septic tanks must be located at least 50 feet away from any source of domestic water supply, at least five feet from dwellings or private property lines and they must be designed to provide access for cleaning and adequate volume for settling and sludge and scum storage (Section 1404-83). Septic tanks are to be made of durable materials which will resist corrosion and decay; and they are to be watertight in order to prevent the entrance of surface drainage, groundwater, or rainwater (Section 1404-87).

Disposal fields are to consist of at least two trenches not more than 100 feet long. They are to be not less than 18 inches nor greater than 36 inches wide, they are to be between 18 and 36 inches deep, and they are to be spaced between six and nine feet apart (center to center). The disposal field is to be sited at least 50 feet from any domestic water source, 25 feet from any streams and ten feet from dwellings, large trees, and property lines (Section 1404-87). The total surface area of the disposal field depends upon the number of bedrooms in the residence it serves and the soil quality and texture; precise specifications can be found in Sections 1404-87 to 1404-91. In general, the less pervious the underlying soil, the greater the required effective area of the disposal field. In the case of impervious soils, clay, or rock, a disposal field may not be constructed.

Likewise, the size and depth of a seepage pit depends upon the soil quality and the amount of liquids it will be expected to absorb. Unless there is a depth of at least four feet of porous material for each seepage pit constructed, each pit must extend at least 20 feet below the inlet. However, no pit shall extend to the water table. If water is encountered, the bottom the pit must be raised to a height of two feet above the water table with clean coarse sand (Section 1404-93). If the soil is of heavy, tight clay, hardpan rock, or other impervious formation, a seepage pit may not be constructed (Section 1404-94 [Table IV]). Other specific requirements for the design and construction of a seepage pit are given in Section 1404-91 to Section 1404-94.

A traditional septic system requires little maintenance other than occasional pumping to remove accumulated sludge. Care should be exercised by users to refrain from disposing of large quantities of harsh household chemicals into the septic system; these will injure or kill the microbes which breakdown the solids in the system, leading to a greater strain on the system and a greater risk of system failure.

Alternative Onsite Sewage Disposal Systems

The Alternative OSDS referred to in this handbook is a constructed wetland or one of its variants. This system mimics the action of a natural wetland, which filters and purifies water before it finally makes it to the sea. Household wastes are initially discharged into a multi-chambered septic tank, as in a traditional system. However, rather than a disposal field or a seepage pit, the septic tank overflow is carried to the constructed wetland, where it undergoes secondary filtration. In the constructed wetland, coarse gravel and plant roots filter the liquids. Additionally, the roots absorb moisture and nutrients while helping to break down waste materials. Plant leaves release water through evapotranspiration, reducing the liquid load on the system. Effluent, if there is any, may be used in a gray water system.

There are three common approaches used to build a constructed wetland: lined trenches, concrete troughs, and tubs. These three approaches share several important considerations:

Septic Tank

Alternative OSDS must employ a three-chambered septic tank with the same required capacity as the septic tank in a traditional system. See Table 1. The first chamber must occupy 50% of the total volume of the tank. The remaining 50% of the volume is divided equally between the second and third chambers which function as a secondary separator. For traditional systems that are being retrofitted to serve as alternative systems, the original septic tank may be used as the first chamber. A second appropriately sized tank, divided into two equal sections can serve as the required secondary separator. Use of a three-chambered tank improves treatment efficiency by creating conditions more favorable for separation of solids and floatables as the wastewater moves through the system. See Figures 2a and 2b.

The septic tank must be watertight and designed to provide access for cleaning and adequate volume for settling and sludge and scum storage. Connections to the constructed wetland cells should be a minimum of four-inch piping with waterproof seals to prevent leakage. Gravity feed should be employed whenever possible; where it is not possible, a pump should be utilized.

Wetland Cells

The wetland cells may take several different forms. Common forms are concrete troughs, trenches lined with impervious material and plastic tubs. Each cell is filled with gravel and dirt to facilitate secondary treatment of the effluent.

Concrete troughs are particularly well suited for applications where well-structured stabilization of a step slope is desirable. An alternative OSDS using concrete troughs is illustrated in Figure 3.

Excavated trenches with an impervious liner at least 20 mils (0.5 millimeters) thick may be used as wetland cells. A layer of sand should be placed in the trench before installing the liner to protect the liner from being pierced by protruding rocks and other irregular surfaces. Particular care should be take when placing the gravel and soil in the trenches to avoid piercing the liner. The likelihood of damaging the liner can be reduced by filling the trench with water prior to putting the rock or gravel in place. The presence of water also assists in ensuring that the top of the rock and soil layers is level. Excavated trenches are best use in settings where there is a need for the cells to follow the natural contour of the site.

Tubs such as those made for use in watering cattle may be used as wetland cells when connected end-to-end. This configuration facilitates easy expansion of the wetland system and also installation of the system on step grades, confined and irregularly shaped spaces. Care should be taken to have progressive cells in the connected series lower than the previous cells in order to avoid upstream cells overfilling before effluent moves completely through the system.

The following should be considered for all configurations of wetland cells:

Location: Wetland cells should not be located where they will be subjected to flooding from stormwater runoff, nor should they be placed where surface drainage from the cells can reach any domestic water supply.

Grading: The site should be graded to direct surface runoff away from the alternative OSDS and, if necessary, to facilitate gravity flow through the system.

Setback Requirements: There are no setback requirements for the watertight wetland cells.

Cell Volume Requirements: The total volume in cubic feet of the wetland cells should provide at least 0.75 cubic feet for each gallon of the septic tank's capacity. It is recommended that the width of each cell be at least two feet.

Cell Walls: The walls of all wetland cells must be impervious. The thickness of the liners shoud be increased as the likelihood of damage increases. This might be due, for example, to rocky surrounding soils, sharp edges on the gravel or other adverse conditions.

Material in Cells: Cells should be at least 24 inches deep. The bottom layer of material should be no closer than 8 inches to the top of the cell. It should consist of clean, washed rock or gravel from 1 inch to 3 inches in diameter. This layer should be covered by a pervious fabric separator on which 6 inches of topsoil or washed pea gravel (1/2 to 1 inch in diameter) is placed. See Figure 4.

Outlets: Cell outlets must be placed such that the level of liquid in the cells rises, at a maximum, to the pervious fabric separator, or 8 inches from the top of the cell.

Plants: When choosing plants the function of the system and the surrounding ecosystem should be taken into account. For example, ornamental plants from a different region of the world could cause problems if they escape into an ecosystem that does not have efficient controls on their growth. Plants

with high water uptakes such as canna lily, ginger lily, ornamental ginger, heliconia, bird of paradise, elephant ear, dieffenbachia, and cattails are best suited for use in the wetland cells. See Appendix A.

Allow sufficient time and take other measures such as fertilizing and irrigating to ensure the plants are well-established prior to operation of the OSDS. Proper spacing and density should be allowed to provide for maximum liquid uptake by the plants and to lessen overcrowding.

Maintenance: Constructed wetlands may be kept in proper working condition with very little maintenance. The vegetation planted in the cells requires no more care than it would elsewhere. The plants should be kept healthy and sufficient in number so they can provide adequate transpiration and filtration. The plants will be affected by drought, particularly if there are extended periods of low flow through the wetland cells. Occasionally, the plants may require additional watering and pruning. Dead plants should be removed and replaced as necessary.

The use of harsh household chemicals, especially cleaning agents, should be avoided whenever possible, as they are harmful to the plants upon which the effectiveness of the system depends. Many natural substitutes for harsh synthetic chemicals are available. Information about such substitutes can be obtained through DPNR or the University of the Virgin Islands' Cooperative Extension Service.

As with any wastewater treatment system, introduction of non-biodegradable materials should be avoided. This would include plastics, wood, metals, cloth and other materials that would not readily decay.

Cleaning: Like a traditional system, the alternative OSDS will require occasional cleaning. The septic tank will require periodic pumping (every 3 to 4 years) to remove sludge. This would principally accumulate in the first of the three chambers. Conceivably, sludge can gradually build up in the wetland cells, compromising their effectiveness. This is highly unlikely though, due to the additional settling opportunities provided by the second and third chamber in the septic tank. When sludge has accumulated in the wetland cells, the soil and gravel media will have to be removed, replaced and the wetland cells will have to be re-vegetated. How frequently this will have to occur will depend upon the volume and characteristics of the waste treated by the system.

Comparison of Systems

A tabular comparison of traditional and alternative OSDS is provided in Table 2.

Permits Required for Alternative OSDS

Anyone who plans, constructs, installs, extends, alters, repairs, operates or maintains an alternative OSDS must do so in accordance with a permit issued by the Department of Natural Resources. This includes homeowners who wish to build, repair, or replace an OSDS; engineers and architects who plan and design onsite systems; building and plumbing contractors who would construct, install, or maintain them; and others who are involved with OSDS in any of the above capacities.

Anyone proposing to develop land for building construction that will utilize an OSDS must first obtain an overall site evaluation to determine the suitability of the location for onsite sewage disposal before

permission will be granted to develop the property. If it is determined that the site is unsuitable for a septic tank and disposal field or seepage system, then an alternative OSDS shall be required.

In order for DPNR to issue a permit to construct or install an alternative OSDS, the following items must be submitted for review:

1. A completed alternative OSDS application;
2. Planning materials which consist of;
    a. An overall site plan;
    b. A 100-year flood plain map;
    c. A soil survey;
    d. The location of water wells;
    e. A complete report detailing the types of onsite facilities or systems to be considered and their compatibility with area-wide drainage and groundwater; and
    f. An onsite drainage plan.

The application for is available from DPNR. A sample of the form is presented in Appendix B. The planning materials must be assembled with the assistance of a licensed engineer or architect, and the property owner must submit them. In addition, if a single onsite system is to be used for more than a single owner dwelling, then the rules and regulations concerning cluster systems must be followed.

The Department of Planning and Natural Resources will respond to a completed application, including planning materials and payment of appropriate fees, within thirty (30) days.

Summary and Conclusion

The policy of the Government of the Virgin Islands and the Department of Planning and Natural Resources is to protect and preserve the waters of the Virgin Islands from pollution and to assist the residents of the Virgin Islands in obtaining safe and adequate sewage disposal facilities. In an effort to reduce nonpoint source pollution from failed septic systems and to provide a mechanism for ensuring the adequate treatment of domestic wastes where traditional systems are unsuitable and access to public sewers is impracticable, the Water Pollution Control Rules of the Virgin Islands have been revised to encompass the construction and operation of alternative OSDS which effectively treat domestic wastes. These systems may be constructed where the two-to-four feet of pervious soil necessary for traditional systems is unavailable, where the topography is too steep, or the site is otherwise unsuitable for traditional systems.

These alternative systems use the same principle to cleans wastewater as wetlands: water is filtered by rocks, absorbed by the roots of wetland plants, and released through the leaves into the atmosphere while bacteria ant other microbes associated with root systems break down and utilized the organic solids. These systems are appropriate for the Virgin Islands, where such constructed wetlands can operate year-round, unaffected by the climatic extremes that occur in the mainland United States.

The design, construction and operation of these systems will be permitted by the Department of Planning and Natural Resources. Persons involved in the design, construction, extension, repair, operation, or maintenance of these systems must do so in accordance with the guidelines set forth in this handbook and any issued permit.

Alternative OSDS provide residents of the Virgin Islands added flexibility in meeting the challenge of protecting and preserving our greatest natural resource, the waters of the Virgin Islands. These systems allow homes to be sited on properties that might otherwise not be useable for residences.

Table 1

Minimum Capacities for Septic Tanks

Number of Bedrooms	**Minimum Liquid Capacity of Septic Tank in Gallons***
2 or less	1000
3	1200
4	1500
5	2000
6	2150
7	2300
8	2450
10	2750

* Note: Increase minimum liquid capacity by 50% when household garbage grinder discharges into the OSDS. *(From: Title 19, V.I. Rules and Regulations, Chapter 53, Section 1404 – 84)*

Table 2

Comparison of Traditional and Alternative OSDS

	Traditional OSDS	**Alternative OSDS**
Oversight	Dept. of Health	DPNR
Site Requirements	No access to public sewer, large area of flat or gently sloping ground with four feet drainage between bottom and water table.	No access to public sewer.
Setback Requirements		
Septic Tank	50' from domestic water supply. 25' from streams 10' from dwellings, large trees and property lines	50' from domestic water supply. 25' from streams 10' from dwellings, large trees and property lines
Seepage Pits/Leach Fields and Wetland Cells	100' from domestic water supply. 10 feet from lot lines.	No setback requirements for CZM, Zoning Code setback requirements must be met.
Advantages	Well-established practice, low cost.	Self-contained system; provides effective treatment in a compact area. Performance does not depend upon topography or soil characteristics. No setback requirements for CZM.
Disadvantages	Not suitable for all areas.	Less well known.
Limitations	Disposal of harsh household chemicals should be minimized.	Disposal of harsh household chemicals should be minimized.
Maintenance	Occasional sludge removal.	Occasional sludge removal.
Costs	Variable.	Variable, typically 10% to 30% greater than traditional systems.

Figure 1. Traditional OSDS

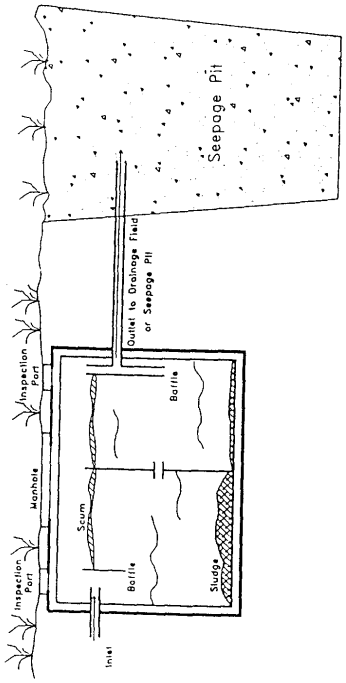


Figure 2a. Typical Retrofitted OSDS (Plan View)

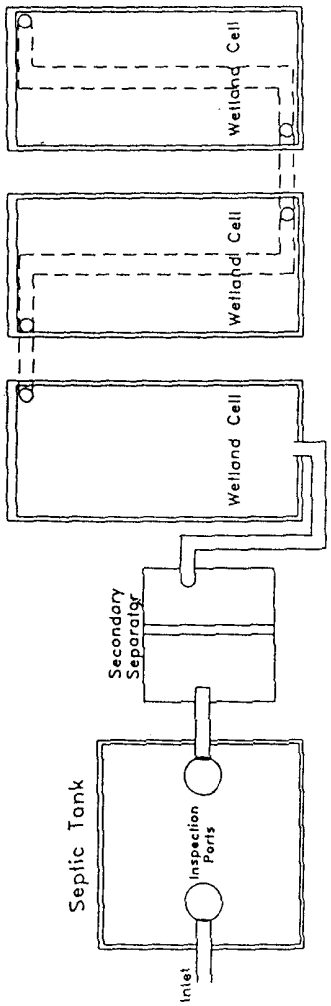


Figure 2b. Typical Retrofitted OSDS (Cross Section)

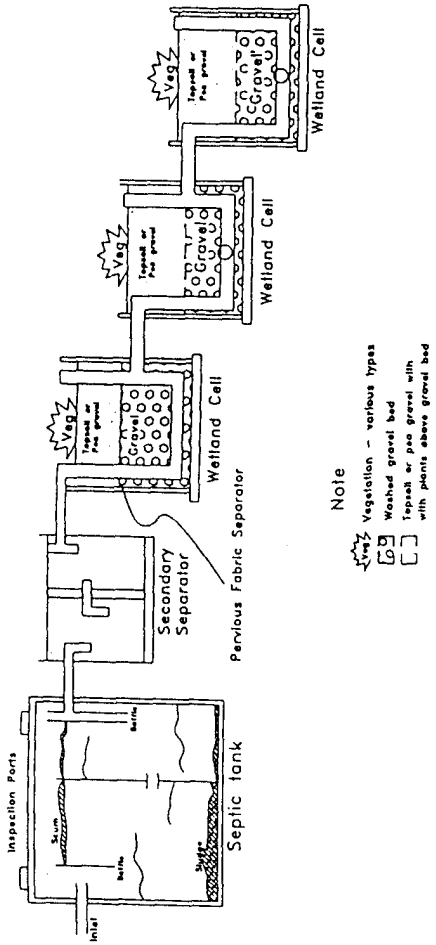


Figure 3. Alternative OSDS

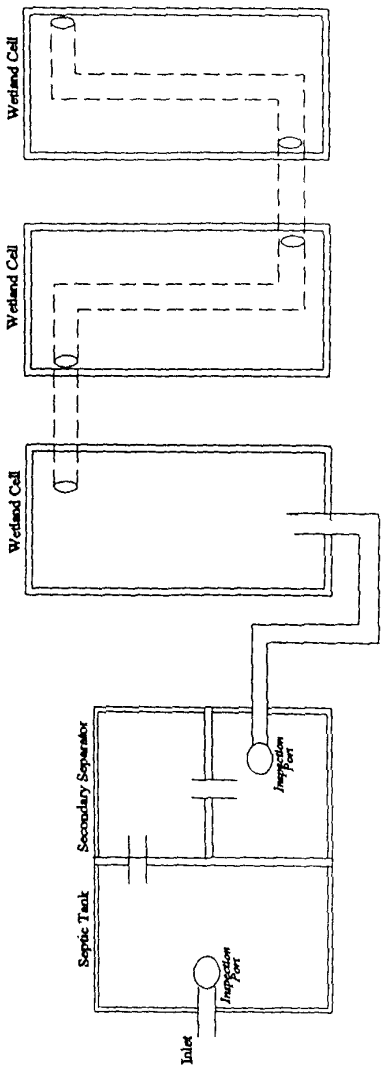
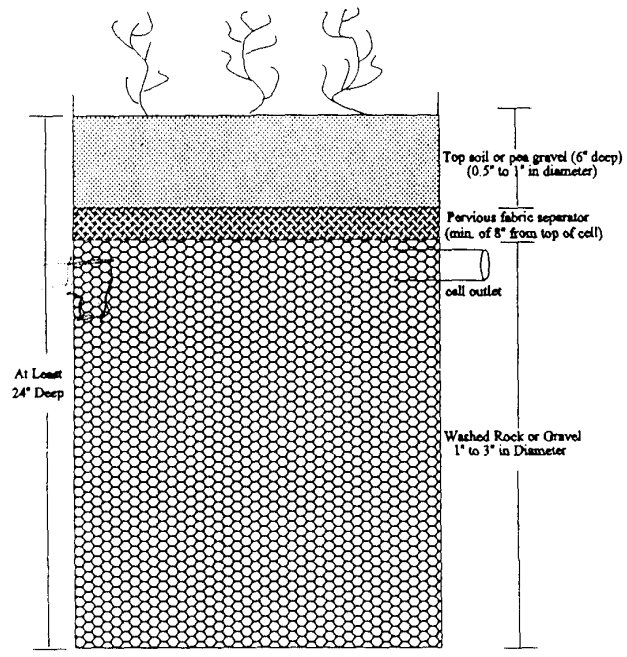


Figure 4. Placement of Material in Cells



Appendix A

Guide to Plants That Can Be Used in Constructed Wetlands *

Common reed: ***Phragmites australis***

Giant bulrush: ***Scirpus validus***

Elephant ear: ***Colocasis esculenta***

Arrowhead: ***Sagittaria lancifolia***

Prairie cordgrass: ***Spartina pectinata***

Canna lily: ***Canna flaccida***

Haliconia:

Spider Lily:

- Information obtained from D. Surrency, *Evaluation of Aquatic Plants for Constructed Wetlands,* CRC Press, Inc. 1993 and *Guidelines for Establishing Aquatic Plants in Constructed Wetlands,* USDA, NRCS, 1996 and University of Virgin Islands, Cooperative Extension Service.